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Event handling using static and dynamic task allocation strategies

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Introduction

This project deals with task allocation where there are multiple types of tasks. The robots will handle tasks that appear throughout the environment according to threshold-based task allocation strategies.

We first propose static strategies where the weights of the stimuli are fixed and the thresholds are individual. We compare the homogeneous experiment, where all robots have the same threshold, to the heterogeneous case, where the robots adapt there thresholds depending on the time spent in search or by specializing in a peculiar task.

In an attempt to improve performance by avoiding multiple robots selecting the same task, we analyze the benefits of a dynamic strategy where each robot emits a virtual potential field for the task type it selected. The robots use the intensities of the potential field separately for each type of task and use this additional information to dynamically adjust the weights of the stimuli.

1. Experimental Setup

1.1 Task Handling Experiment

To assess the efficiency of our algorithms, we consider the task handling problem where 3 types of tasks appear in a closed arena. A task, represented as a colored cylinder (with colors being red, green or blue), is processed by a robot being in its vicinity for a given amount of time, but is not processed faster as the number of robots close to its position increases. Once a task is processed, it disappears and a new one appears at a random location. The goal of our algorithms is to optimize the task allocation so as to prevent multiple robots from picking the same task.

Robots identify the tasks with the onboard camera. Each robot evaluates stimuli for red, green and blue tasks based on its local camera observations (perceived colors and pixel count, relative sizes in number of pixels). The stimuli for red, green and blue are multiplied by weights wr, wg, wb. The robot will then select the task according to our thresholds-based algorithms. Once a robot reaches a task it stops until the task is processed and disappears.

In order to emit the virtual potential field, the robots are endowed with radio emitter (and receiver) that broadcasts (and gathers) the relevant information perceived by the robots, within a short range. These information are then fed into our public and individual threshold-based algorithm to dynamically adjust the weights of the stimuli.

1.2 Implemented simulator

[WE COULD DESCRIBE OUR IMPLEMENTATION HERE BUT OPTIONAL]

2. Task Allocation Mechanism

The purpose of this project is to assess the benefit of dynamic, or adaptive, thresholds-based algorithms over static ones (whether it be the homogeneous or heterogeneous case). To do so, we introduce two performance metrics, one being the number of tasks processed within a time period and the other one being the average distance traveled per processed task. While the former gives us an idea of the average rate at which actions are performed, the latter embeds two notions at the same time: the distribution of workload among robots and the efficiency of the allocation in terms of distance from robots to tasks.

For the simulations to be comparable, we used the same Finite State Machine (FSM) for all simulations and all types of algorithms. The behavior of the robots could be described as follows. All the robots are initialized in the first state that consists in performing random turns and processing the image from the camera to determine if task needs to be handled. Once a task is picked, the robot changes state and goes directly towards the task. When the robot is close enough to the task, it stops for a given amount of time to process the task. Since the tasks are spawn at random locations, we wanted to maintain the randomness of the system. With this in mind, and as proposed in [1], we implemented an additional state that consists in performing random movements for a short period of time to thwart this tendency.

The framework used during the course of the project allowed us to test 3 main approaches. They could be divided in two categories, one being private (static case) and the other being public (dynamic case). On the one hand, we considered both homogenous (fixed and identical thresholds among robots) and heterogeneous (adative thresholds based on each robot's perception) cases. On the other hand, we took advantage of the local potential field emissions perceived by the robots to adjust the weights of each color stimulus to improve task allocation (though the thresholds are fixed).

2.1 Private, Fixed-Threshold Algorithm

[DESCRIBE THE ALGORITHM AND THE TUNING OF THE PARAMETERS]

2.2 Private, Adaptive-Threshold Algorithm

[DESCRIBE THE ALGORITHM AND THE INITIALIZATION OF THE PARAMETERS AND THE ADAPTATION PROCESS]

2.3 Public, Fixed-Threshold Algorithm

[DESCRIBE THE ALGORITHM AND THE INITIALIZATION OF THE PARAMETERS AND THE ADAPTATION PROCESS (BASED ON POTENTIAL FIELD)]

3. Results & Discussion

[EXPERIMENT 1: WE COULD TRY DIFFERENT THRESHOLD VALUES AND COMPARE PERFORMANCES — EXPERIMENT 2: WE COULD TRY DIFFERENT ADAPTATION FUNCTIONS AND COMPARE RESULTS — EXPERIMENT 3: WE COULD TRY DIFFERENT ADAPTATION FUNCTION FOR STIMULI AND COMPARE RESULTS — LAST PART: COMPARE ALL ALGORITHMS WITH BEST PERFORMANCE]

Conclusion

Bibliography

[1] Nidhi Kalra and Alcherio Martinoli. "Comparative study of market-based and threshold-based task allocation". In: *Distributed Autonomous Robotic Systems 7*. Springer, 2006, pp. 91–101.